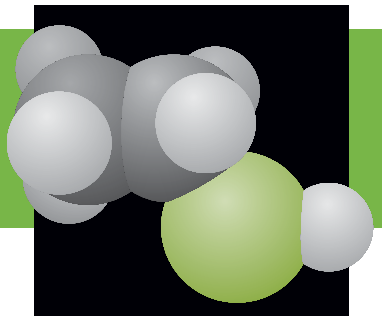
Technology Success Story

# CHEMICALS



## Olefin Recovery from Chemical Industry Waste Streams

### Benefits

- Energy savings of 0.8 trillion Btu per year by 2020
- Recovery of over 0.42 billion pounds of olefins per year
- Material cost savings—refinery-grade olefin feedstock is worth $0.15 per pound–nearly four times its value as a fuel ($0.04 per pound)

### Applications

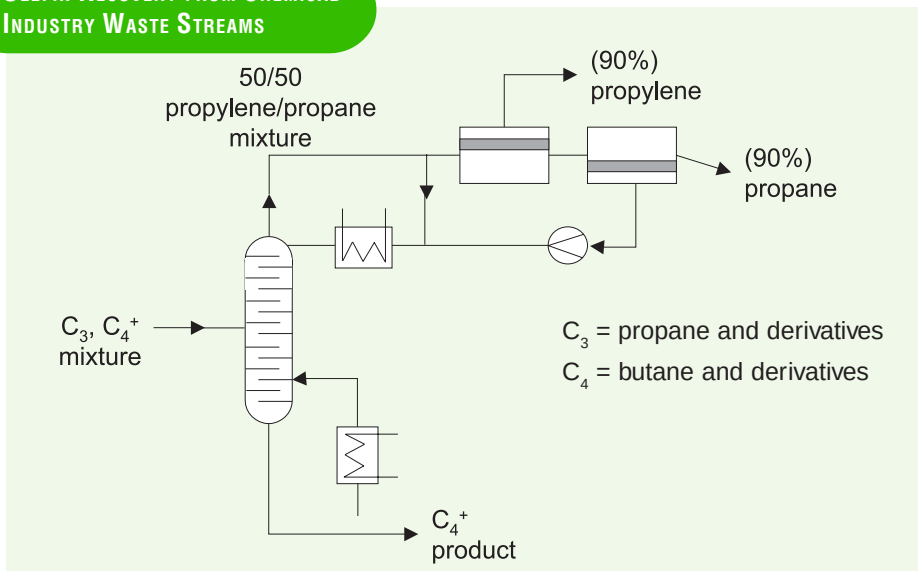
Olefins may be recovered from many chemical production processes, such as those for polyethylene, acrylonitrile, polypropylene, and cumene. Approximately 0.42 billion pounds of olefins are potentially recoverable in the United States. Other applications include recovery of propylene from refining streams. An estimated 80 percent of plants producing olefin-containing vent streams could ultimately adopt this technology, and new plant capacity is growing at 3.8 percent per year. Opportunity also exists outside the United States, where olefin recovery is currently considered cost-prohibitive.

## Membrane Separation Recovers Olefins from Gaseous Waste Streams for Use as Chemical Feedstocks

Selective polymer membranes are being developed to allow recovery of olefins from petrochemical by-product and vent streams. Olefins are compounds, such as ethylene and propylene, which have carbon-carbon double bonds. These gaseous streams are often flared or used as a fuel even though the olefins are more valuable as chemical feedstock. The new separation technology will allow olefin separation and recycling as a feedstock within the process.

The U.S. chemical industry produces more ethylene (40 billion pounds) and propylene (25 billion pounds) annually than any other organic chemicals. A major portion of the production cost for these chemicals is associated with olefin/paraffin separation (e.g., ethylene/ethane). This high-cost, energy-consuming step is currently performed in large distillation columns. To manage the build-up of inert gases, such as propane and ethane, a fraction of the olefin/paraffin is continuously removed. The olefin lost with the paraffin can represent 1 to 2 percent of the total feed to a polyolefin plant, with an annual value of approximately $1 million per plant. Unless an olefin/paraffin splitter is used to recover these by-products, the feedstock value of the gas is wasted.

**Olefin Recovery from Chemical Industry Waste Streams**




**Olefin recovery from waste will use a propylene/propane membrane separation system installed on the overhead vapor from a refinery depropanizer column.**

## Project Summary

The project partners developed a membrane separation process to recover olefins in gaseous olefin/paraffin waste streams for use as in-process feedstock. The process is based on the polymer membranes selectively permeating the olefin component of propylene/propane. The membranes could also be applied to monomer recovery from vent streams or in combination with distillation for propylene feedstock production.

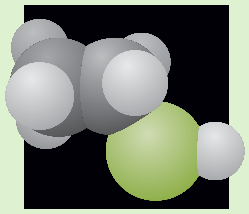
Researchers experimented with composite membranes to establish membrane permeation properties and optimize membrane structure. Based on pilot tests, the selected membranes were further enhanced to improve performance in industrial environments. Scale-up modules were then developed and pilot tested at Phillips Sumika, providing data for technical and economic analyses. A second test is currently underway at an Equistar polypropylene plant.

## Commercialization

Researchers believe the first application of this process will be propylene recovery from by-product and vent streams throughout U.S. industry. Current technology does not allow plants to economically separate these streams, which are generally used as fuel or are occasionally flared. Researchers estimate that this process can recover 0.42 billion pounds of olefin currently lost each year as waste gas. Recovery of this gas leads to a total annual energy savings of 0.8 trillion Btu by the year 2020. Membranes with more advanced properties could be used competitively to replace distillation or, in hybrid systems, to recover olefins from the stream-cracking process. Other possible applications include pollutant reduction associated with combustion of fuels.

## Awards

MTR received Chemical Engineering Magazine's 1997 *Kirkpatrick Achievement Award* for developing a related membrane process for the separation of propylene/nitrogen and ethylene/nitrogen streams that are also produced in polyethylene and polypropylene production.



### Project Partners

Membrane Technology
Research, Inc. (MTR)
Menlo Park, CA

Phillips Sumika Polypropylene Company
Bartlesville, OK

Equistar
Houston, TX

### For additional information, please contact:

Charles Russomanno
Office of Industrial Technologies
Phone: (202) 586-7543
Fax: (202) 586-1658
E-mail: charles.russomanno@ee.doe.gov

Dr. Hans Wijmans
Membrane Technology and Research, Inc.
Phone: (650) 328-2228
Fax: (650) 328-6580
Email: wijmans@mtrinc.com

Please send any comments, questions, or suggestions to
webmaster.eren@nrel.gov

Office of Industrial Technologies
Energy Efficiency and
Renewable Energy
U.S. Department of Energy
Washington, D.C. 20585

March 2003